PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Apparatus for producing Hydrogen Gas

I, EUGENE MICHIELS, a French Citizen, of 8, Piazza Principe Eugenio, Rivoli, Turin, Italy, do hereby declare this invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns an apparatus for producing hydrogen gas, of the type comprising a housing, a vaporising chamber and a tubular reaction chamber containing a reagent capable of reducing steam to hydrogen connected in series with the said vaporising chamber, both chambers being arranged in the said housing, means for feeding water to said vaporising chamber and means, for simultaneously heating both chambers.

The object of this invention is to provide an improved apparatus of the type disclosed above capable of economically producing gaseous hydrogen.

According to this invention the vaporising chamber provided in an apparatus of the above type comprises a helical tube wound about the said tubular reaction chamber and is connected at its end remote from its connection with the reaction chamber with an atomiser for supplying thereto water under pressure.

According to a further feature of this invention, when the apparatus is intended to produce hydrogen gas which may be used as a fuel in internal combustion engines, the housing enclosing the tubular reaction chamber and vaporising coil is the exhaust manifold of an internal combustion engine, the reaction chamber being connected at the end remote from the connection with the vaporising chamber to the carburettor of the said engine.

The construction of the apparatus according to this invention is such that the apparatus can be built up as a compact unit of small size.

Notwithstanding the reduced overall size of the apparatus, the vaporising chamber can be large enough to produce a great quantity of steam. It affords an extensive heat exchange surface and supplies steam under pressure so that the steam can flow through the charge of the reagent in the tubular reaction chamber.

Two embodiments of this invention are illustrated by way of example in the accompanying drawings, in which:—

Fig. 1 is a diagrammatic view, partly in section, of a first embodiment of this invention; and

Fig. 2 is a similar view of a second embodiment.

In the embodiment illustrated in Fig. 1, the apparatus comprises a reaction chamber 1 in the form of a steel tube which may conveniently contain pure iron filings or turnings 2 as a reducing substance capable of reducing steam to hydrogen.

Whilst the tube 1 has been illustrated as being vertically disposed, it could, of course, have any other convenient orientation.

One end of the tube 1, the lower end shown in the drawing, is connected to a conduit 3 leading to a vaporising chamber 4 in the form of a helical tube disposed about the tube 1; the lowest point of the conduit 3 is furnished with a drain cock 5 serving, when open, for draining liquid water from the conduit 3.

At its upper end, the tube 4 communicates with a valve-controlled atomiser 6 through which water may enter the tube 4 in the form of a fine mist.

For heating the tubes 1 and 4, an electrical resistance coil 7 is wound about the tube 1 between the latter and the tube 4; the latter is preferably in thermal contact with a thermally conductive sheath 4^1 embracing the coil 7 so as to ensure adequate heat transfer from the latter to the tube 4.

The tubes 1 and 4 are arranged in a housing 8 which comprises a protective casing packed inside with asbestos.

The whole apparatus may be mounted in any convenient way; as shown in the drawing, a stand 9 may be employed to support the apparatus.

In operation of the apparatus, water, preferably under a pressure of from 1.2 to 1.5 atmospheres, is fed to the atomiser 6 *via* a tube 12; this water is atomised and enters the tube 4 as a fine mist which on traversing the tube 4 is converted into dry steam by the heat emitted by the coil 7 which is suitably energised. The steam then passes through the conduit 3 to the reaction chamber 1 wherein it reacts with the heated iron filings or turnings 2 and is reduced to hydrogen. The latter escapes from the upper end of the tube 1 *via* a delivery tube 1*a* which may be connected to a suitable carburettor for an internal combustion engine.

The embodiment illustrated in Fig. 2 differs from that illustrated in Fig. 1 in that the apparatus is embodied in the exhaust manifold of an internal combustion engine so that the heat contained in the exhaust gas of such engine may be utilised for heating the tubes 1 and 4, thus eliminating the coil 7.

Thus as shown in Fig. 2, a reaction chamber tube 1, conduit 3, and vaporising chamber tube 4 of the apparatus are mounted within the exhaust manifold 10 of an internal combustion engine so that exhaust gases leaving the exhaust ports 13 of such engine may pass over such parts of the apparatus before passing out through the exhaust pipe 11. The tube 4 is spaced from the tube 1 to permit free circulation of the exhaust gases around and over these tubes. As in the case of the apparatus illustrated in Fig. 1, water, preferably under pressure, is fed *via* the tube 12 to the atomiser 6; any surplus water reaching or lying in the conduit 3 may be drained off through the drain cock 5 which is mounted externally of the manifold 10. Hydrogen produced in the tube 1 issues from the tube 1*a* and is fed to a suitable carburettor for the engine.

In either of the two above-described embodiments, the production of hydrogen depends on three factors, namely:—

(a) The temperature of the vaporising and reaction chambers;

(b) The volume of steam generated in the vaporising chamber;

(c) The volume and disposition of the iron filings or turnings in the reaction chamber.

Factors (a) and (b) can be controlled by the layout of the apparatus and the adjustment of the atomiser 6; factor (c) is determined by the dimension and disposition of the reaction chamber and its contents and in this connection it should be observed that for economy in iron filings or turnings, the reaction chamber should be of small diameter and great length so that the steam passing therethrough is maintained in contact with the iron for as long as possible. Of course, the reaction chamber should have a cross-sectional area sufficient to pass the requisite volume of steam without restriction and the necessity for maintaining a high pressure differential between the ends of such chamber.

The two embodiments of the apparatus described are capable of generating considerable volumes of hydrogen within a short period and of maintaining a continuous flow of hydrogen until the iron has been converted to oxide. The gas generated is very pure and constitutes an ideal fuel when correctly mixed with air; explosions may be avoided by suitably regulating the gas-air mixture so that the nitrogen and other gases in the air serve to neutralise the explosive tendencies of the mixture.

Needless to say, a single vaporising chamber of suitable capacity could be arranged to feed steam to a plurality of reaction chambers (all, if desired, mounted within the exhaust manifold of an internal combustion engine), thereby providing for a greater production of hydrogen. Moreover, it is possible to gain heat from the engine, by locating the reaction chamber directly on the heads of the engine cylinders.

Whilst iron filings or turnings have been described as suitable reagents for effecting reduction of steam to hydrogen, any other suitable reagent could equally well be employed. The reagent, when exhausted, could either be replaced or regenerated, for example by passing hydrogen thereover.

What I claim is:—

1. Apparatus for producing hydrogen gas, of the type comprising a housing, a vaporising chamber and a tubular reaction chamber containing a reagent capable of reducing steam to hydrogen connected in series to the said vaporising chamber, both chambers being arranged in the said housing, means for feeding water to said vaporising chamber and means for simultaneously heating both chambers, wherein the said vaporising chamber comprises a helical tube wound about the said tubular reaction chamber and is connected at its end remote from its connection with the reaction chamber with an atomiser for supplying thereto water under pressure.

2. Apparatus according to Claim 1, wherein said heating means comprises an electrical resistance adapted, when energised, to heat said vaporising and reaction chambers.

3. Apparatus according to Claim 1 or 2, wherein said electrical resistance comprises a coil wound about said tubular reaction chamber between the latter and said vaporising chamber.

4. Apparatus according to Claim 1, wherein the housing enclosing the tubular reaction chamber and vaporising coil is the exhaust manifold of an internal combustion engine, the reaction chamber being connected at the end remote from its communication with the vaporising chamber to the carburettor of the said engine.

5. Apparatus for producing hydrogen gas, substantially as hereinbefore described.

6. Apparatus for producing hydrogen gas, constructed, arranged and operating substantially as hereinbefore described with reference to Fig. 1 of the accompanying drawings.

7. Apparatus for producing hydrogen gas, constructed, arranged and operating substantially as hereinbefore described with reference to Fig. 2 of the accompanying drawings.

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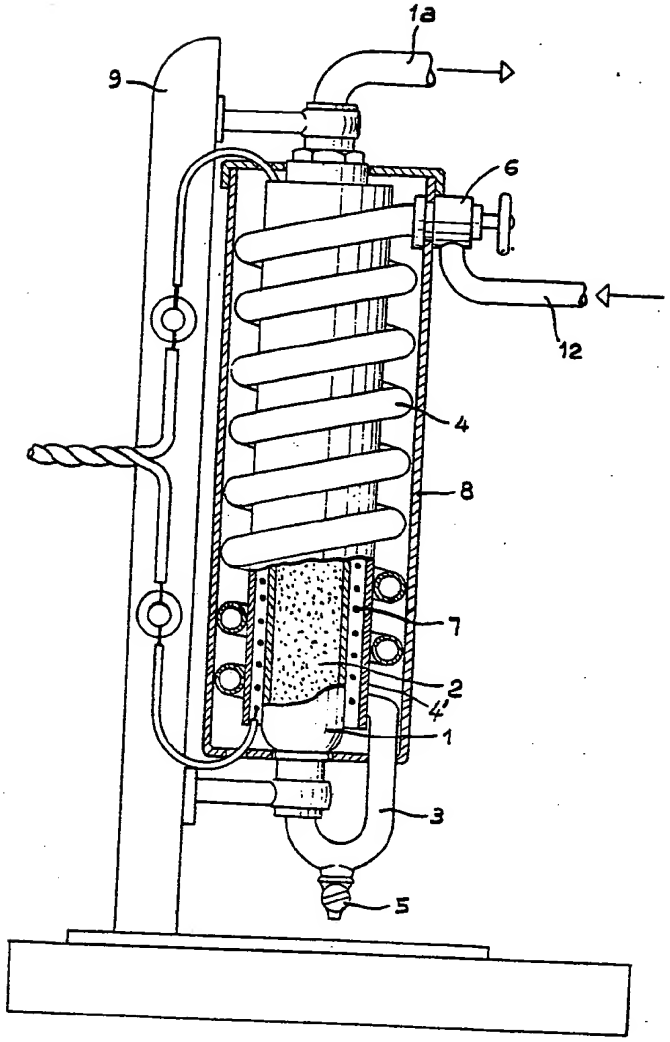
Fig. 1



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2 SHEETS

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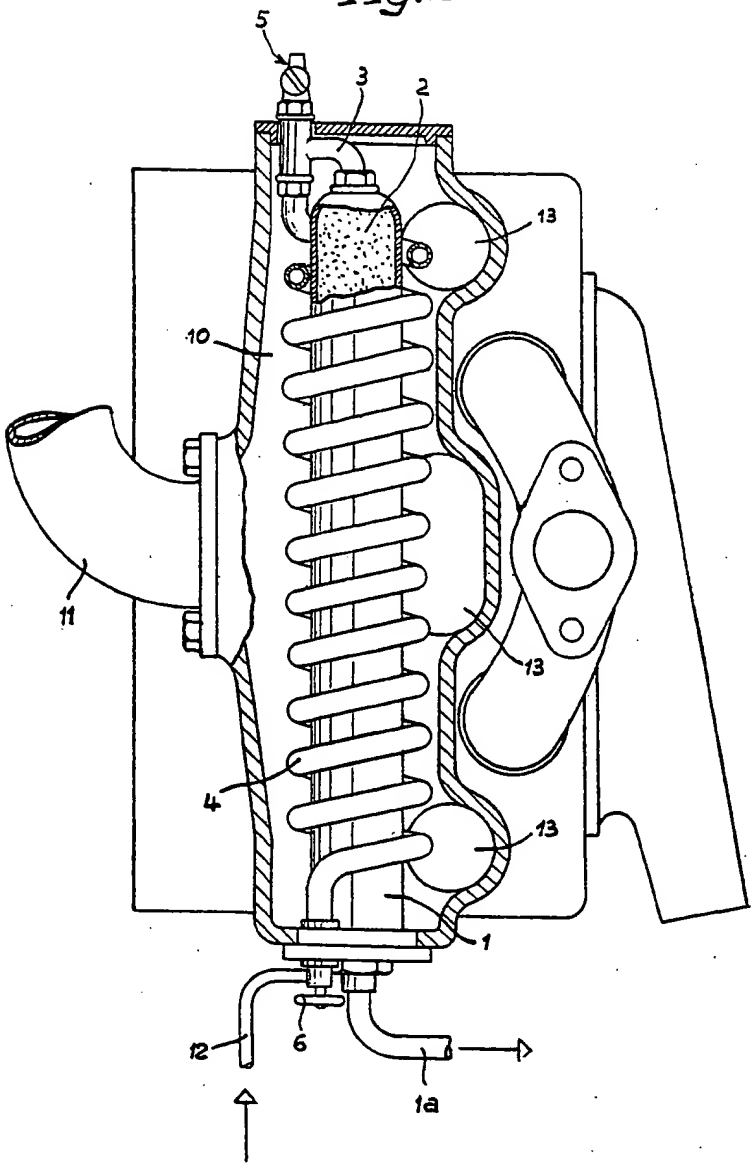
SHEETS 1 & 2

Fig. 2



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SHEETS 1 & 2

Fig. 2

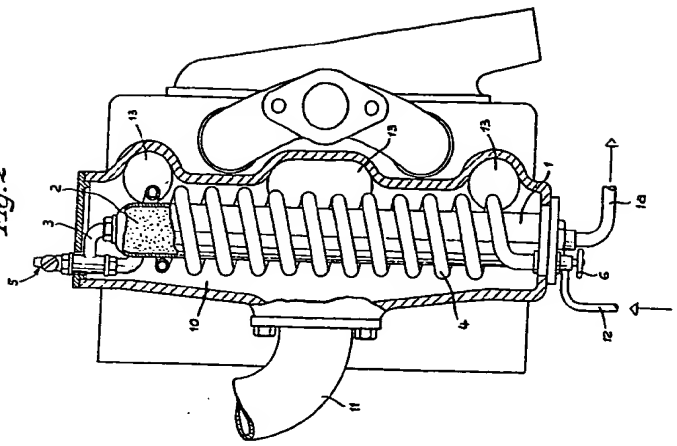

Fig. 1